III.—*Report on the Caoutchouc Tree of Assam made at the request of Captain* Jenkins, *Agent to the Governor General. By* William Griffith, *Assistant Surgeon on deputation with the Bhotan Mission.*

[Communicated by the Government.]

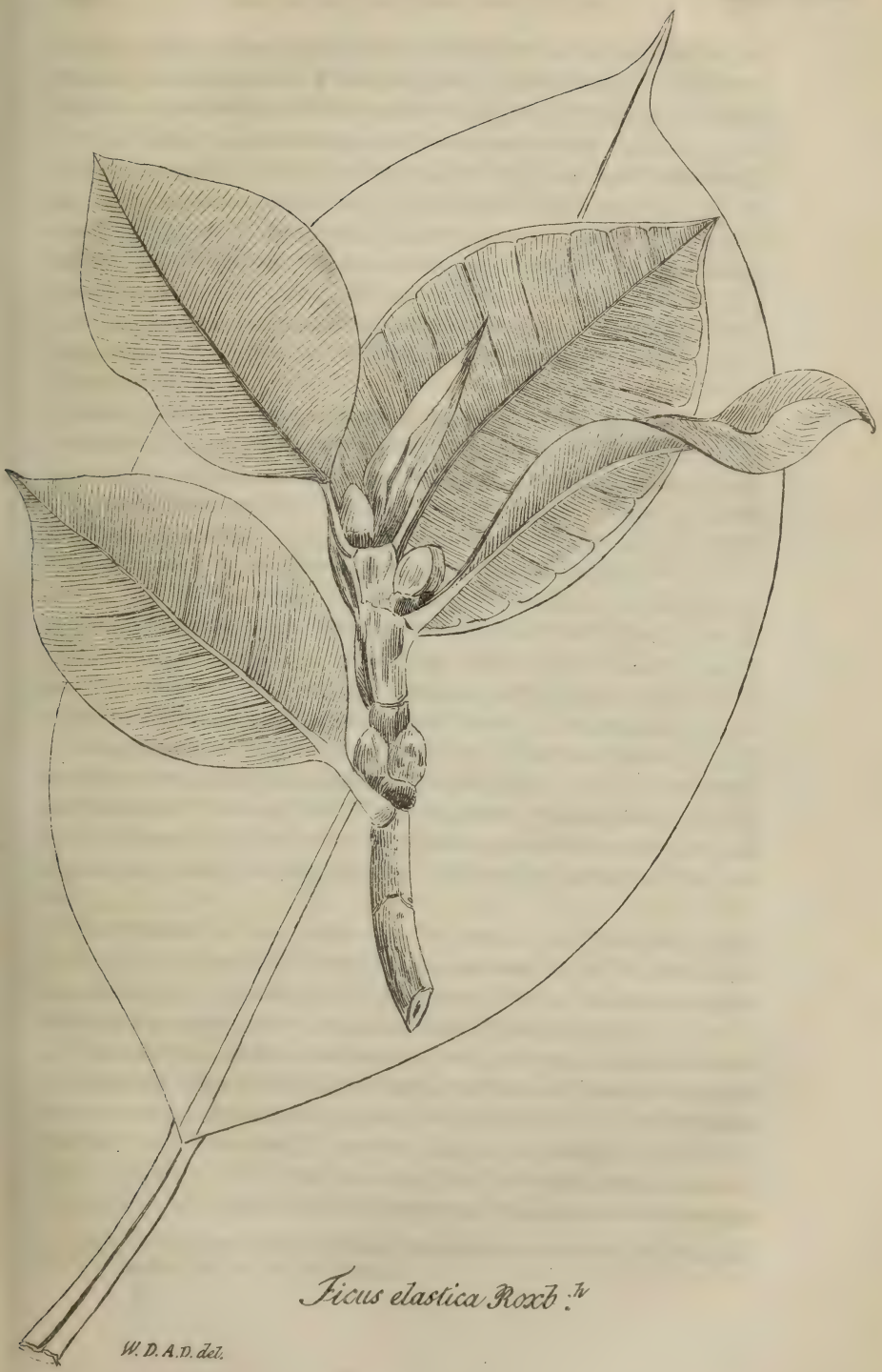
Agreeable to your instructions I proceeded to *Ferozepoor*, and thence, accompanied by Lieut. Vetch and Mr. Brownlow, to the forests in which the tree yielding the caoutchouc is found.

The forests alluded to, form what is evidently the *Tarái*, and they probably extend almost without intermission, from the western to the eastern extremity of the valley, at least on its northern boundary.

The breadth of the forest tracts is variable; in the parts we traversed it was computed to be between 7 and 8 miles. The forests are of a decidedly tropical character; exceptions, however, to this occur towards the basis of the hills, near which some trees indicative of a temperate climate are found, such as horse and spanish chesnuts, an alder, Hovenia dulcis. No particularly fine timber trees occurred with the exception of a solitary chaum tree, the Artocarpus chaplasha of Dr. Roxburgh. The caoutchouc tree itself occurs very generally as a solitary tree*, occasionally however two or three may be found grouped together. In size they are far superior to all the other trees, and especially in the extent of surface covered by their branches. They certainly deserve to be ranked amongst the largest known trees, being probably inferior in size to the banian only, which may be said to be capable of indefinite extension; such is the size indeed of the caoutchouc tree, that it may be distinguished from a distance of several miles by its dense, immense, and lofty crown. The dimensions of one of the largest were as follows: circumference of main trunk 74 feet; ditto of main trunk and the supports 120 feet; ditto of area covered by the branches, 610 feet; estimated height 100 feet. The trees appear to be, so far at least as I have had opportunities of judging, confined to the *Tarái*, the drier parts of which they seem to affect, and they become more abundant towards the foot of the hills. They are said, however, to occur about some of the villages in this direction; if so, they have probably been planted there, at any rate it is quite certain that on the southern side of the valley, along which considerable spaces occur totally devoid of forests, they are comparatively uncommon.

In the tracts of forests traversed by us and which I have said was estimated to be between 7 and 8 miles in length, 80 trees were seen: of these by far the greater number were of large size.

* This tree is known to the Assamese by the name *Borgach*, to the Khasiyas by that of *Ka-gi-ri*.



Ficus elastica Roxb. Nv

W. D. A. D. del.

Oriental Lith. Press. Calcutta.

As we have reason for supposing that they are equally abundant throughout the districts of *Chárdwár*, some approximation to their real number may be formed. Thus taking the length of the belt of forests in this district to be 30 miles, and its average breadth 8, we may form so many sections, each of the diameter of 100 yards, 50 yards being the utmost extent to which one is able to see on either side owing to the extreme thickness of the jangal. In the above thirty miles 528 sections will be formed, and the total number of trees, taking 80 as the average of each section, will be 42,240, and however overestimated this may subsequently prove to be, it is evident that the tree is very abundant, since, even in the infancy of the scheme, 300 maunds of juice have been collected in 30 days.

Nothing definitive can be stated of the probable number of trees in the whole valley. It is known to exist about *Goálpára* and at *Borháth*, on the south side of the valley, and I think that it will be found to exist along both sides, wherever a belt of *Túrái** exists. I have no doubt but that *Assam* alone will, when the value of the juice becomes more generally known to the natives, be able to meet all demands.

The tree likewise exists in plenty on the *Khásiya* mountains, on which it occasionally ascends as high as 4500 feet. Mr. Royle, in his Illustrations, p. 336 says, that it does not extend beyond *Pandua*, *Jaintipur* and *Chirra Punji*, but this statement is apparently made on no other grounds than that of its not having been then found elsewhere.

The geographical range of the tree, as far as has been hitherto ascertained, may be stated to be between 25° 10′ and 27° 20′ north latitude, and between 90° 40′ and 95° 30′ east longitude. Throughout this space it will be found in the densely-wooded tracts, so prevalent along the bases of hills, and perhaps on their faces up to an average elevation of 22,500 feet.

The attention of the public was, it appears, first directed to this tree by the celebrated Dr. Roxburgh, a man worthy of the estimation he was held in by government, both on account of his extensive strictly botanical knowledge as well as of that of vegetable statistics.

The manner in which this discovery was made was given as follows: "Towards the close of 1810, Mr. Matthew Richard Smith of *Sylhet* sent me a vessel there called a turong filled with honey in the very state in which it had been brought from the *Pándua* or *Jaintipur* mountains, north of *Sylhet*. The vessel was a common, or rather coarse basket in the shape of a four-cornered, wide-mouthed bottle, made of split ratans,

* Lieut. Vetch has since ascertained that the tree is as abundant in the district of *Naudwár*, as in that of *Chárdwár*.

several species of which grow in abundance amongst the abovementioned mountains, and contained about two gallons. Mr. Smith observed that the inside of the vessel, was smeared over with the juice of a tree which grows on the mountains. I was therefore more anxious to examine the nature of this lining than the quality of the honey. The turong was therefore emptied and washed out, when to my gratification I found it very perfectly lined with a thin coat of caoutchouc*." Dr. Roxburgh then mentions one or two facts, which are consonant with the views of modern vegetable physiology, viz. "that old trees afford a better and more indecomposable juice than young ones, and that during the cold season the juice is better but more scanty than in the hot. It is extracted by incisions across the bark down to the wood, at a distance of about a foot from one another, all round the trunk or branch up to the top of the tree; and the higher, the more abundant is the fluid said to be. After one operation, the same tree requires about a fortnight's rest, when it may be again repeated†." The only description hitherto given of the tree is that of Dr. Roxburgh; it was drawn up from young specimens, but it is quite sufficient to enable one to recognise the plant. I subjoin a sketch of the only flowering branch I have hitherto met with. The roots of this really noble tree spread out in every direction on reaching the ground, and the larger ones are half uncovered: they occasionally assume the appearance of buttresses, but never to such an extent as those of some other trees. The nature of the trunk of this and some other species of the same genus is so extraordinary that it may not be amiss to make a few remarks on its structure. It differs in the first place from the ordinary form of trunk by its sculptural appearance, and it is from this that its extremely picturesque appearance arises.

The appearance arises entirely from the tendency of these trees to throw out roots both from the main trunk as well as from the branches, and from the extreme tendency these have to cohere with the trunk or with each other. If the roots are thrown out from or very near the main trunk, they ordinarily run down its surface, and cohere with it firmly and hence the sculptured appearance; if, as happens in some, they are thrown out from the branches at such a distance from the trunk that they do not come in contact with it, they pass down to the earth, and form what I call supports. These attain their maximum of developments in the banian and render the growth of the tree quite indefinite. These supports appear never to produce leaf, bearing branches, so long, at least, as they remain attached to the tree. They are generally per-

* Roxburgh's Flora Indica, Vol. III. p. 543.

† Roxburgh's Flora Indica, Vol. III. p. 544.

fectly straight at first, becoming conical only by divisions at the apex when near the earth, and by the mutual adhesion of these divisions.

Very generally, it would appear, this species, as well as some others, vegetates in other trees; its first processes of growth being probably similar to those of other arboreous dicotyledons. The roots, however in obeying the laws regulating their descent, soon come into contact, and wherever they do so, a mutual and firm adhesion is the result.

A net work is soon formed round the tree; the size of its reticulations soon diminishes with the increase in the number of roots; and at last a nearly solid and excessively firm cylinder is formed, which encloses, as it were in a case, the tree which originally protected the young seedling: to such an extent is this carried that the death of the tree is sure to occur sooner or later.

In such a case as this the fig-tree has, it may be said, no trunk at all comparable to ordinary trunks, which result from growth in an ascending direction. In these they originate from the aggregation and cohesion of roots, or from growth in a descending direction. One may hence readily imagine how easily such trees may overtop all others, for, if they vegetate on a tree 60 feet from its base, it is at once obvious that this distance is an actual gain in height over all the others. Such instances are perhaps the only ones in which epiphytes destroy the plants on which they grow. They may indeed be denominated parasitical epiphytes. As might be expected the seeds are indifferent as to the species of tree on which they vegetate: it is not uncommon to find two fig-trees entwined in a close embrace.

Dr. Roxburgh was aware of this manner of growth, but he appears to have only seen palmyra trees enclosed in the way I have endeavoured to explain. The tendency to throw out roots is so excessive in the Ficus elastica, that any section through the back of the trunk or the supports of sufficient depth to reach the wooded structure, is sure to occasion their appearance. These roots or radicles are distinctly continuous with the outer fibres of the last formed wood, and so many are thrown out that the lower extremity of a transverse section of a support not unfrequently assumes the appearance of a very coarse tail. The union between the root commences by abrasion, and although I have not yet examined sections with reference to the degree of intimacy of union, I have but little doubt but that each union is an instance of true and spontaneous grafting.

The inflorescence of this tree remains to be explained, particularly as it would at first sight appear to be totally different from that of any other, and because such forms unless reduced to ordinary types, confuse

the minds of beginners. By the old school, the only one yet known on this side of India, and which even in England has too many advocates, each instance, almost, of anomalous form is at once elevated into a distinct or *sui generis* formation, as if nature in her wonderful workings had no distinct plan.

This was, and is, the great fault of the Linnæan School of Botany, and it is continually causing curious and really, at this period, quite inexcusable mistakes. If we turn over the pages of Roxburgh's Flora Indica, which relate to this genus, we shall find that the fruit is described before the flower—described in fact before it can possibly exist.

That which Roxburgh called the fruit is the inflorescence, and consists of a hollow, more or less closed receptacle, on which minute flowers of different sexes are arranged. A receptacle on which a number of flowers is situated, is by no means uncommon, and I may point out familiar instances in the thistle, artichoke, dandelion, &c. in which the receptacle may be said to be almost at its maximum of development. Frequent instances of such enlarged receptacles occur in the natural order to which the fig belongs, particularly in *Dorstenia*.

In all these the receptacle is more or less flat; were we to take one of these flat receptacles and so dispose of it, that it shall become closed except at its apex, we shall have an inflorescence similar to that of a fig, the scales found at the aperture of which are analogous to the scales visible outside the heads of the beforementioned instances, and which, as is well known, form the edible heart of the artichoke. A fig may therefore be compared with the head of a compound flower, however different it may appear at first sight to be*.

The last point I have to notice with reference to these plants, is that they are, more especially the peepul, frequently infested by some parasites†.

The juice is procured from transverse incisions made in the larger root, which I have mentioned as being half exposed. The incision reaches the wood, or even penetrates it, but the flow of the juice takes place in these instances from the bark alone.

Under the incision a hole is scooped out in the earth, in which a leaf, folded up into the shape of a rude cap, is placed; for this purpose the leaves of Phrynium capitatum of Linnæus seem to be preferred.

* A fig might be proved almost to be an artichoke.

† M. De Candolle reasoning on the supposition that no parasites existed on trees furnished with milky juice, constructed an ingenious theory, which I have long known to be invalidated in the instance of the jack-tree.

This plan is simple, and far superior to that of incising the trunk as it ensures greater cleanliness. The larger roots are preferred in addition to their being half exposed, for yielding a richer juice.

The fluid on issuing is, when good, nearly of the consistence of cream, and of a very pure white.

Its excellence is known by the degree of consistence, and the quantity of caoutchouc, on which this would appear to depend, is readily ascertained by rubbing up a few drops in the palm of the hand, when the caoutchouc rapidly becomes separated. By kneading this up again, it rapidly becomes elastic.

Many incisions are made in one tree. The juice flows rapidly at first, but the rapidity diminishes after a few minutes.

It is said to flow fastest during the night: it continues during two or three days, after which it ceases, owing to the formation of a layer of caoutchouc over the wound.

The quantity obtainable by the above method from a single tree has not yet been exactly ascertained. Some of the natives affirm that four or even five maunds may be procured; others only give one ghurrah full or ten seers as the amount procurable. From the slowness with which it flows, I should consider half a maund to be a fair average produce of each bleeding. The operation is repeated at the expiration of 18 or 20 days. Assuming the rate of half a maund to be nearly correct, 20,000 trees will give as the aggregate of four bleedings 12,000 maunds of caoutchouc, that is if Dr. Roxburgh's proportion of this product to aqueous matter, viz. $15\frac{1}{2}$ oz. to 50, be correct.

I should however, observe that the proportion of caoutchouc in the American juice is given by Dr. Faraday as 45 in 100*, or nearly one in two. On the excellence of the Assamese products as compared with that of America, it does not become me to pronounce. If strength, elasticity, clearness and freedom from viscidity as well as from foreign matter be test of excellence, then this product may be considered superior to any other hitherto manufactured. Nothing can in fact well exceed, at least in these points, the best specimens manufactured by Mr. Scott. It has been pronounced by persons resident in Calcutta to be excellent, and the only objection that has hitherto been raised against it *on sufficient examination* is that of Mr. Bell, who says it snaps. But if by this we are to understand snapping from being allowed to return to its original dimensions from the state of tension, the objection amounts to an excel-

* *Mechanic's Magazine*, 24, 440. Mr. Scott finds that the proportion varies from four to six parts in 10, the variation depending probably on the part of the tree from which the juice is extracted.

lence. Mr. McCosh has indeed declared it to be inferior to the South American article, but this decisive judgment has evidently been made on casual examination of perhaps the worst possible specimens. Decisions such as these are totally inadmissible in any work, much more so in the one alluded to* which from the materials placed at the author's disposal, should at least have been correct.

On the points of comparative excellence of the two products we shall soon, it is to be hoped, be set at rest. Lieut. Vetch† has submitted numerous excellent specimens to the London Caoutchouc Company, and Mr. Scott and Mr. Brownlow are engaged on a series of experiments, which promise complete success.

It is to be hoped that samples may be sent to the Society of Arts, whose reports on all these subjects are so excellent and so readily and obligingly furnished. I think, however, it is desirable that Dr. O'Shaughnessy be requested to draw up an analysis both of the Assamese and American products, as that analysis would at once set at rest the comparative amount of caoutchouc as well as of its solubility.

As this tree promises to become an important source of revenue, all possible precautions should be taken, to ensure the present stock from injury and to increase the number of trees so that the province may be able to meet any demand. With reference to the first point it will be quite sufficient to limit the bleedings to the cold months, so that during the season of the greatest activity of vegetation, the trees may remain unmolested, and this is more particularly necessary from our having reasons for supposing that the juice will be during the period alluded to much less rich in caoutchouc. I would thereforepropose the interval between April 1st and November 1st as the season of rest. The size of the tree being such as to preclude any possibility of great injury resulting from the abstraction of the juice, the bleedings if indeed it be possible to limit them, may recur at intervals of one month.

The best check, however, to over-depletion will be the rigorous rejection of all over thin juice. The plan now adopted for the extraction of the juice needs no modifications, for it is simple, effectual and cleanly. For increasing the number of trees the formation of plantations will be necessary. The sites chosen for these should be both in the forests themselves as well as in and about those villages which, from being situated near the edge of the forests, may seem adapted to the end in view.

* Medical Topography of *Assam*.

† It cannot be too well known, that it is owing to the exertions of this officer that the existence of this valuable tree in abundance has been ascertained.

There is every reason for supposing that this tree presents every facility for multiplication by division, and probably the plan pursued by the natives with the peepul will be effectual for this purpose: a branch is chosen of the thickness of a man's thigh, and of a height of 15 or 20 feet; all its branches with the exception of one or two at the apex are to be lopped off clean, and the wounds to be plastered over with clay. The cutting is to be planted out at the commencement of spring, that is in March or April*.

The jangal must be cleared, but not so much so as to expose the cuttings to the full influence of the sun. It must be borne in mind that the tree is one which requires an immense space, should rearing from seed be resorted to, which however, can scarcely be necessary; it must be remembered also, that the most favorable situation for ensuring their vegetation would appear to be on other trees, and they should be so placed as not to be liable to be removed either by rain or wind. Some manure should be placed with them so as to imitate as much as possible that with which they are generally supplied by birds.

The substance, caoutchouc, is a widely disseminated constituent of vegetable fluids. It has hitherto, I believe, been found only in plants with milky juice, although its presence in all plants yielding such fluid remains to be proved. The presence of caoutchouc in silk has been, I believe, attributed to the nature of the fluids of the plants on which the caterpillars feed: but this, although applicable to the mulberry plants, can scarcely hold good with the various species of Tetranthera on which the Moonga feeds, or with the castor-oil plant the chief food of the Eria, which in *Assam* does not appear to yield milk. Milky juice is often characteristic of certain families, but often not: its presence is frequently of importance, as it often affords valuable indications of affinity. It is remarkable that it is almost unknown in the grand division of Monocotyledonous plants. The families in which its presence may be said to be universal are Apocquea, Asclepiadea, Campanulacea, Sobeliacea, and the great division of Compositæ, Chichoracea, of which the lettuce is a familiar example. It is of common occurrence in Euphorbiacea, and Tulicea, which orders may be looked on as the grand sources of caoutchouc. Thus, in addition to our Indian plants, the *American* caoutchouc is supposed to be produced by Cecropia peltata which belongs to Urticea, and the Ule tree of Papantla, from which the caoutchouc of that country is obtained, is supposed to belong to the same orders. I must, however, observe that Baron HUMBOLDT objects to the supposition of

* For this information I am indebted to Captain JENKINS.

Cecropia peltata yielding the *American* caoutchouc, as its juice is difficult to inspissate*.

The order Euphorbiacea would likewise appear to supply a large quantity. Thus Dr. Lindly informs us that the true caoutchouc is furnished by Siphonia elastica, Hevia quiancusis of Aublet, a Surinam and Brazilian tree; and it is from a tree of this order that a substance resembling caoutchouc is procured in Sierra Leone.

Some Apocqueæ are also reported to produce good caoutchouc†; thus Aricola elastica produces the caoutchouc of *Sumatra;* and it is from this plant that caoutchouc has been produced in *Penang* and exported to England‡. Willughbeia edulis is likewise an *Indian* plant from which caoutchouc has been produced, but Roxburgh says it is of indifferent quality; unless I have been misled, good caoutchouc is obtained from Nerium grandifloreum of Roxburgh.

It is probably equally abundant in Asclepiadea; one plant of which order Cynanchum albifloreum has been stated to yield it of excellent quality in Penang. Mr. Royle seems inclined to attribute the great tenacity of the fibres of some plants of both these orders to its presence, but this supposition seems to me of very doubtful accuracy§.

It is to these orders therefore, viz. Tritecia, Euphorbiacea, Apocquea, and Asclepiadea that I would beg to direct particular attention. The relative values of the various caoutchoucs is still open to investigation. The relative values of the milky juice as sources of caoutchouc depend on their freedom from viscidity, and this is very readily ascertained by rubbing up a few drops in the palm of the hand: in freedom from this material nothing can well exceed the juice of the Ficus elastica.

Too much attention in fact can scarcely be paid to all plants affording milky juice; as in the event of a diminution in quantity from the present sources, chemists may possibly devise some means of extracting it from those materials, which at present are disregarded. This of course, only holds good provided the assumption that the juice of all plants of a milky nature contains caoutchouc, proves correct. A historical retrospect of caoutchouc may be found in the Mechanic's Magazine, vol. 24, page 434. In this the opinions of Dr. Anderson, ont he probable future extensive utility of this substance are given at length; the author however appears to consider these views as overdrawn, and

* Lindly's Introduction to Natural system of Botany, p. 176.

† Lindly's Instructions, p. 300.

‡ Royle's Illustrations, p. 329, under Euphorbiacea, and p. 270, under Apocquea.

§ Royle's Illustrations, p. 274.